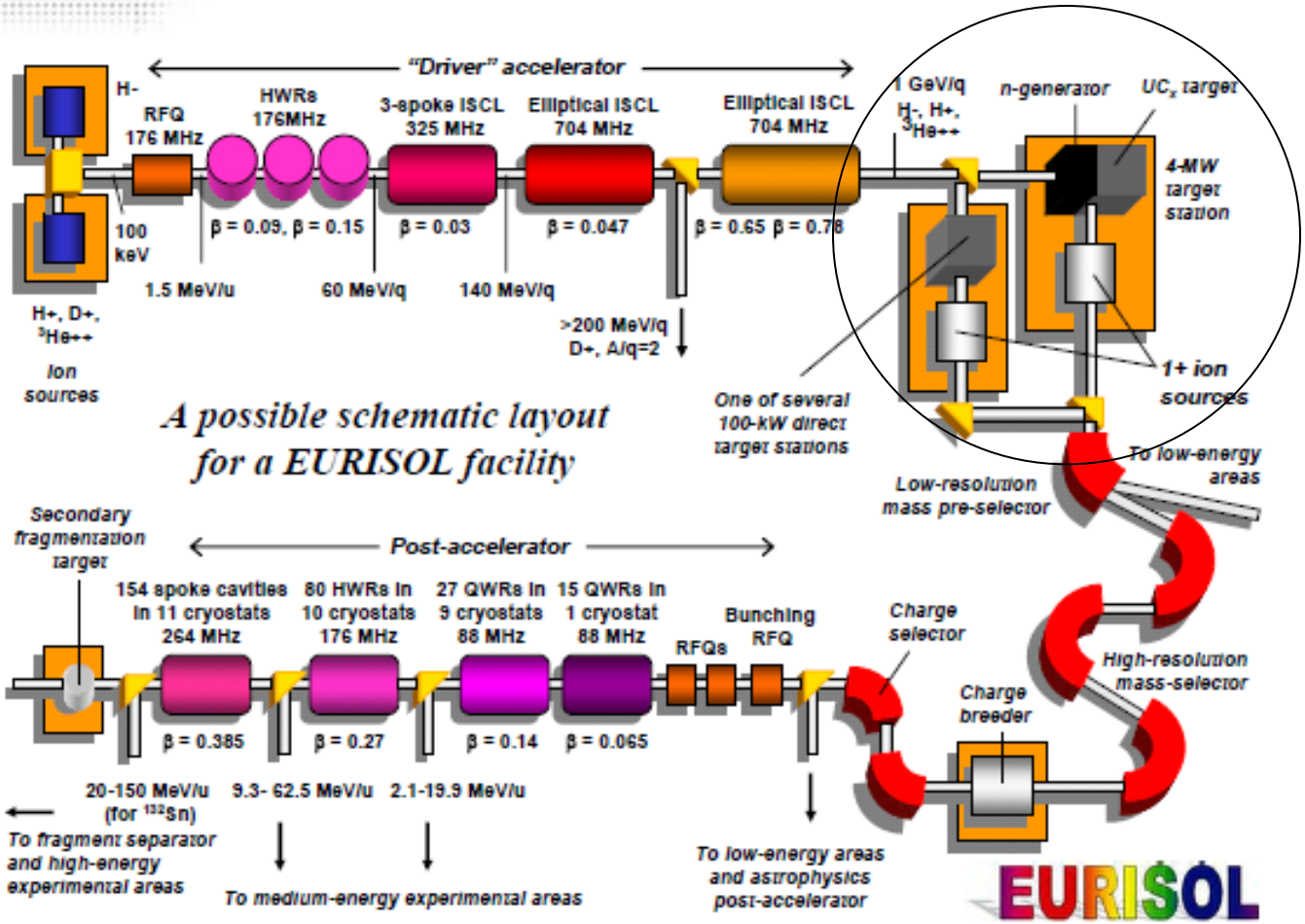
Pb/Bi target loop for EURISOL

Kick-off meeting

CERN, 10th May 2012

T. Stora – EN-STI-RBS

EURISOL RTD(2003) DS(2009)



EURISOL layout after the Design Study

Long tradition to use molten metal targets at ISOLDE

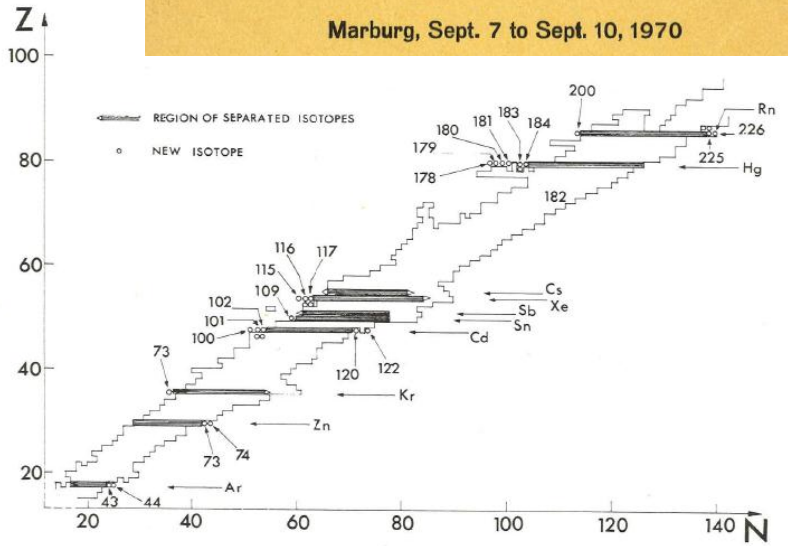
Bundesministerium für Bildung und Wissenschaft

Forschungsbericht K 70-28

Kernforschung

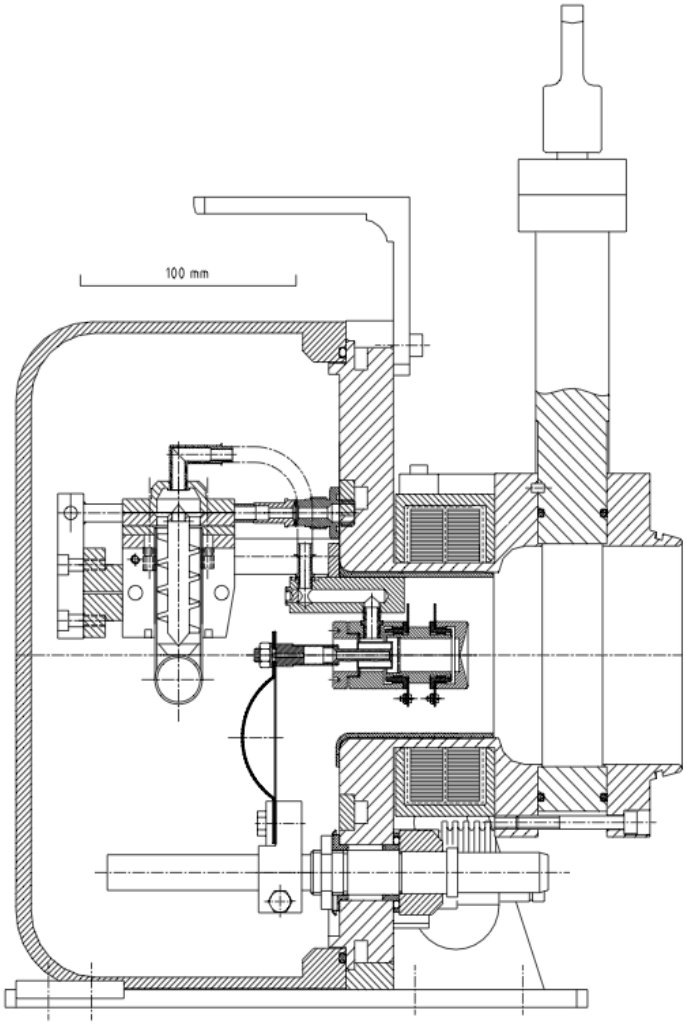
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON ELECTROMAGNETIC ISOTOPE SEPARATORS AND THE TECHNIQUES OF THEIR APPLICATIONS

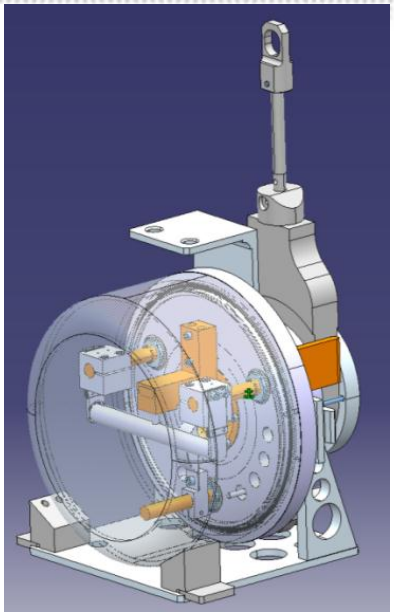
Marburg, Sept. 7 to Sept. 10, 1970

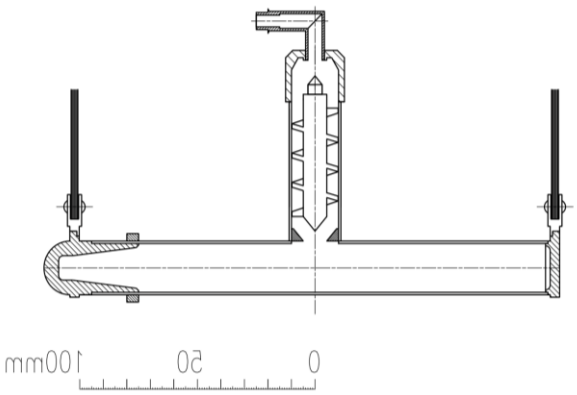


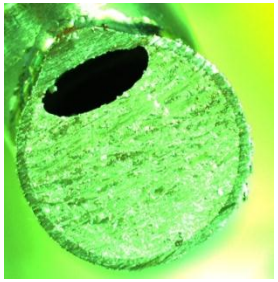
Target Material	Activities released	Target Temp. °C	Line Temp. °C	Comments
$TiO_2 \cdot xH_2O$	Ar	-	-	
$ZrO_x \cdot xH_2O$	Kr	-	-	
$CeO_2 \cdot xH_2O$	Xe	-	-	
$ThO_2 \cdot xH_2O$	Rn	-	-	
Ge(metal)	Zn	1200	600	Air inlets disastrous
Sn(metal)	Cd	1000	600	
La(metal)	Cs	1300	600	Surface ionization source
	Xe	1300	-	Normal ion source, not as good as Ce target
Pb(metal)	Hg (spallation)	760	-	
	Xe (fission)	760	-	
$TeCl_4$	Sb	130	-	
	Sn	130	-	Transport line coated with $SbCl_5$

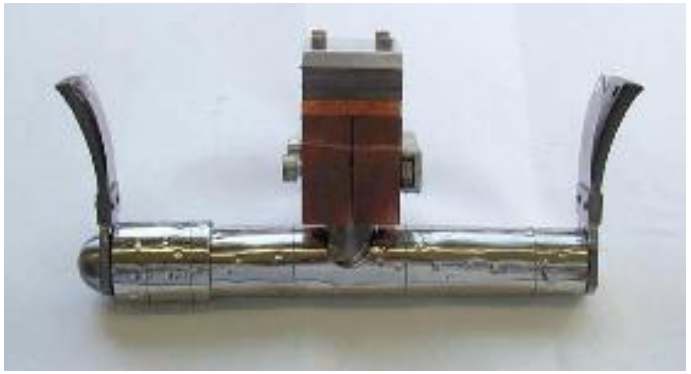
Present static molten Pb target









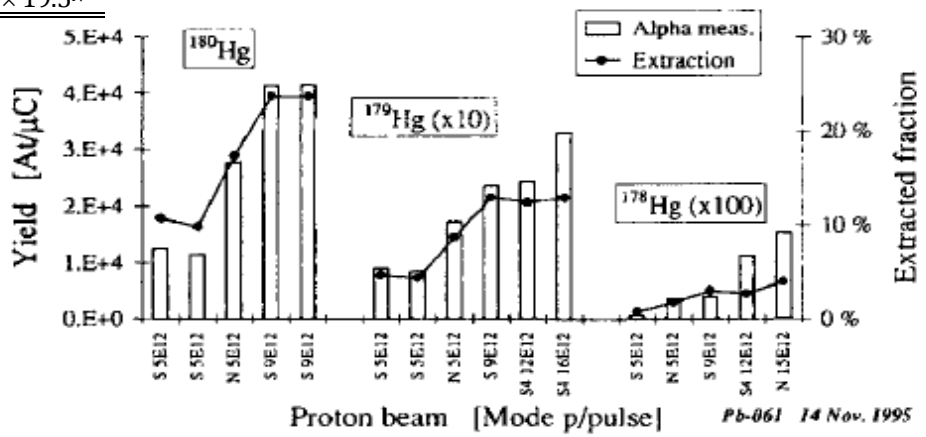


Pb/Bi264 container
after dismantling in 2007

Some operational parameters

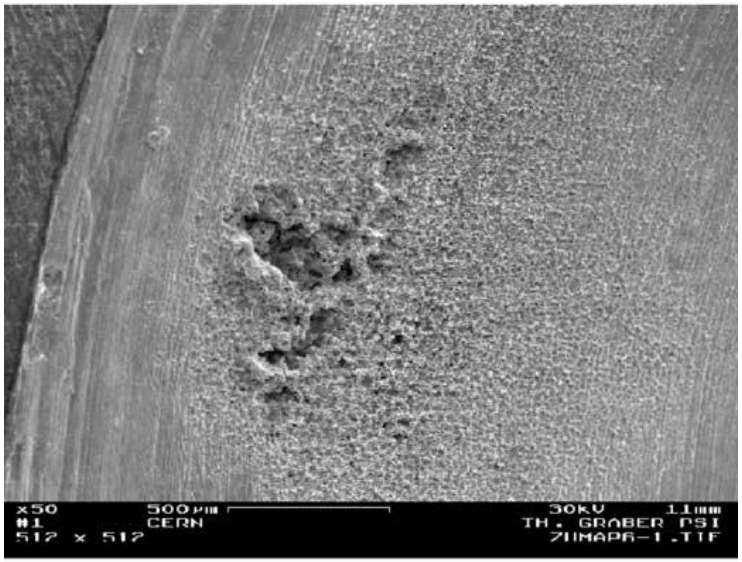
Table 1: Evolution of ISOLDE proton beam parameters on liquid metal targets. Corresponding values for solid state targets are shown in brackets. The repetition frequency and pulse intensities are maximum values. The beam profile is indicated for different beam intensities: [i] 6.5 ×10¹² ppp, [ii] 2 ×10¹² ppp, [iii] 7 ×10¹² ppp, [iv] 3 ×10¹³ ppp.

Parameter	'90s	2004/2005	2009
Energy [GeV]	1, 1.4	1, 1.4	1, 1.4
Number of bunches	5 × 3 (20)	3 (4)	3 (4)
Bunch width [ns]	48	200	200
Bunch spacing [μs]	4 × 0.072, 2 × 10 (0.072)	10 (0.6)	16 (0.6)
Pulse duration [μs]	20 (2.4)	20 (2)	32 (2)
Repetition frequency [Hz]	0.833	0.833	0.833
Pulse max. intensity [10^{12} protons]	10 (33)	10 (33)	10 (33)
FWHM, $v \times h$ [mm]	11 × 7[i]	7.8 × 7.4[ii]	6.7 × 6.4[ii] 8.3 × 10.7[iii] 17.7 × 19.5[iv]



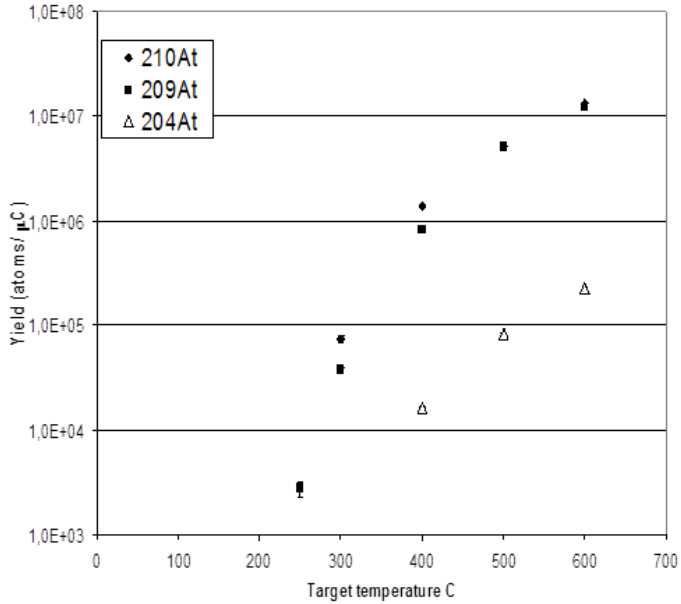
ISOLDE findings related to molten metal targets

At production



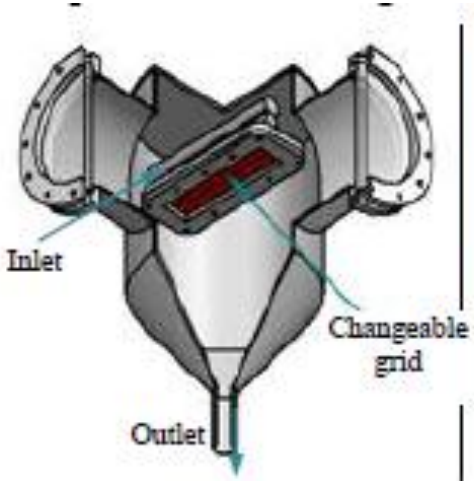
(b)

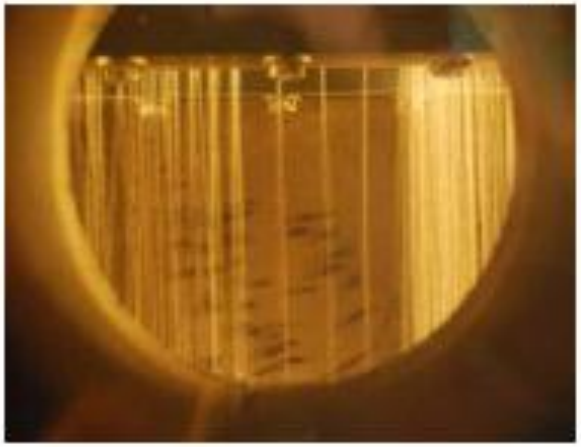
Ta beam window pitting corrosion traces in molten Pb target. (720C, 6.5^{e}12proton/pulse, 20μs pulse duration, σ=3x4.5mm, total 1.3^{e}18protons)



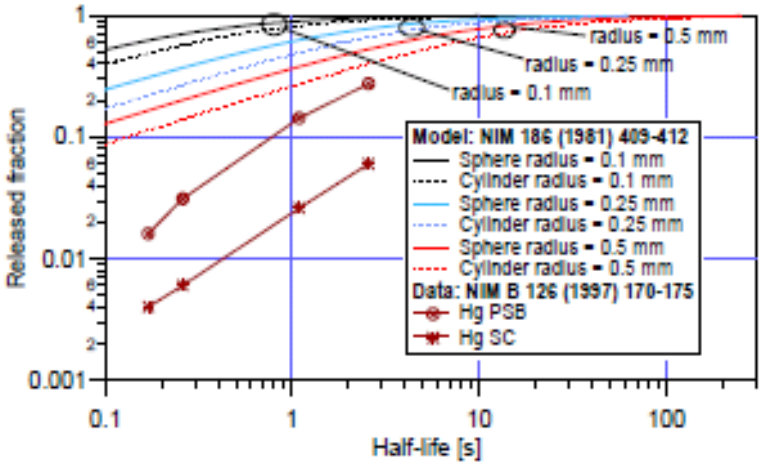
Bi(He,nX)At

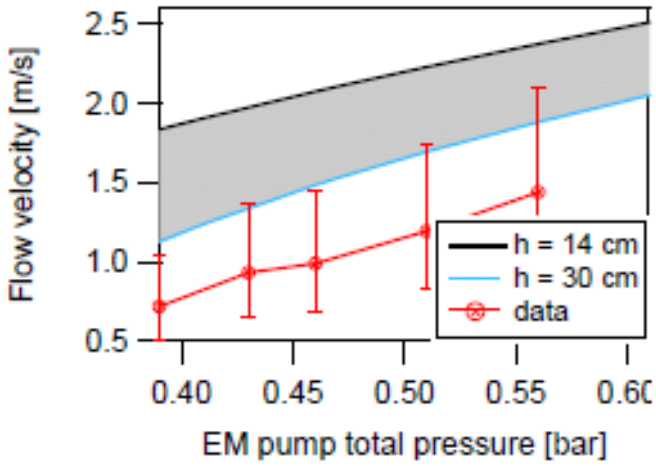
Offline tests of a molten Pb loop





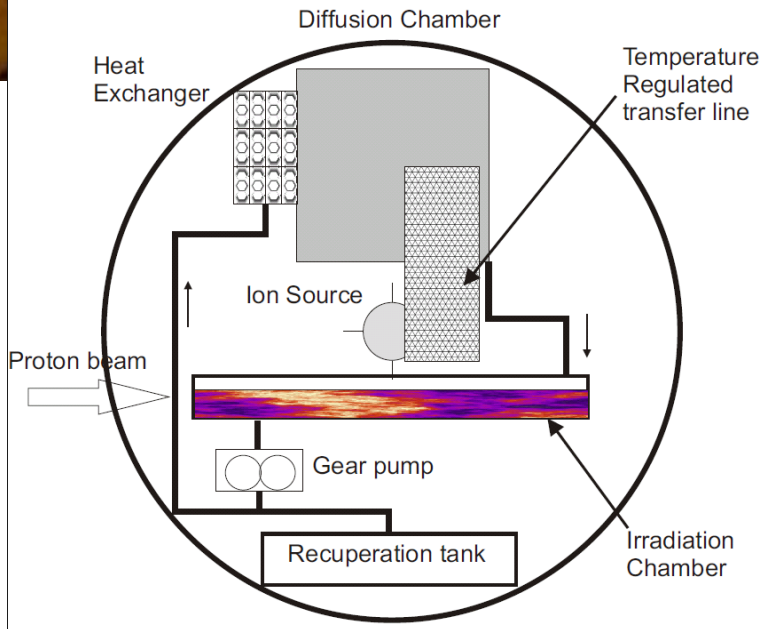
E. Noah, EURISOL-DS @IPUL





Pb/Bi loop online @ ISOLDE

Target material	Pb 44.5% / Bi 55.5%
Melting point / boiling point [C]	125 / 1670
Operating temperature [C]	150-600
Target material density [kg/m3]	10.5 @ 200C; 10.2 @ 400C; 9.9@600C
Thermal conductivity [W/K.m]	11.3 @ 400C
Irradiation cell volume [cm3]	60
Flow rate [cm3/s]	60-200
Pump pressure [Bar]	0.1-2



Collaboration

Institutes	Role in the collaboration	Contact person(s)
LENAC/SPhN/IRFU, CEA, Saclay	Safety file and licensing	V. Blideanu
ESS, Lu nd	Instrumentation	E. Noah, F. Plewinski
IPUL, Salaspils	Offline Pb/Bi loop tests	K. Kravalis
SINP, Kolkata	Radiochemistry	S. Lahiri
CERN, Geneva	Coordination, Design, ISOLDE interface, online tests	T. Stora, AP Bernardes, M. Delonca
SCK-CEN, Mol	CFD simulations, selection of components	P. Schuurmans, L. Popescu, M. Schyns

M1-6	7-12	13-18	19-24	25-30	31-36	Cool Down	CD +1-6
Design	Design	Design					
		Safety file	Safety file	Safety file	Safety file		
			Construction	Adaptation			
			Off-line test	Off-line test			
					Online test		
						Final report	
						Cool-down	PIE
							PIE report

Work packages

WP 1: Coordination
WP2 : Mechanical design and construction
WP3 : Thermomechanical simulations
WP4 : Instrumentation
WP5 : Safety and Licensing
WP6 : Offline commissioning
WP7 : Online operation
WP8 : PIE

Milestones

M1 : Validation of the concept by num. modelling
M2 : Mechanical design
M3 : Selection of components and construction
M4 : Instrumentation & control
M5 : Offline commissioning
M6 : Licensing file
M7 : Online tests

Updated planning

WP	Jun-Sept 2012	Oct-Dec 2012	Jan-Mar 2013	Apr-Jun 2013	Jul-Sept 2013	Oct-Dec 2013	Jan-Mar 2014	Apr-Jun 2014	2014/2016
			CERN-wide Long Shutdown 1						
2 design +assembly	1st design	2nd design		Selection of components	Procurement	Construction	Adaptation		
3 thermo mec simulat.	Cfd + thermomech	Cfd + thermomech							
4 Instrument		Definition	Tests @ IPUL/CERN		Software interface				
5 Safety licensing	Definition of tasks; Output to other WP	Numerical Simulations + collection of info/data		Input from other WP	Input from other WP	Final report	Approval to go online		
6 Offline commissioning		Test selected items @ IPUL	Test selected items @ IPUL/CERN			Start Proto commissioning	Final proto commissioning	Cold check-out in target area	
7 Online Tests				Definition of online tests			Preparation of target area	1 week Tests at Proton start-up.	Final report
8 Waste,PIE									*Waste PIE*

To be discussed further this afternoon

References

EURISOL-DS final report, target tasks, Ed. J. Cornell, sept 2009.

Effects on thermal shocks on the release of radioisotopes and on molten metal target vessels, J. Lettry et al., NIMB204, 251 (2003)
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Post-irradiation analysis of the tantalum container of an ISOLDE LBE target, E. Noah et al., J. Nucl. Mat. Online Nov. 2011.
Volatile elements production rates in a proton-irradiated molten lead-bismuth target, Y. Tall et al., 2007 (http://nd2007.edpsciences.org)

Reserve